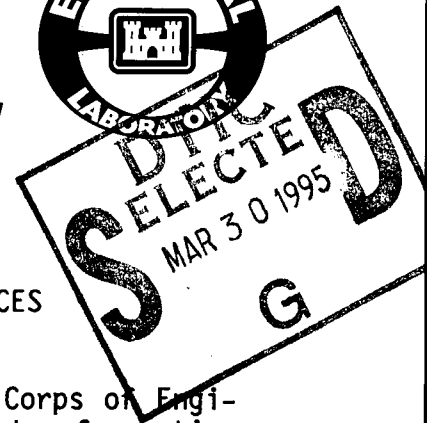




Environmental Effects of Dredging Technical Notes



CURRENT DISTRICT DREDGED MATERIAL DEWATERING PRACTICES

PURPOSE: This technical note summarizes the current US Army Corps of Engineers state of practice in dewatering dredged material. State-of-practice dewatering methods are methods currently in full-scale use by one or more Corps of Engineers District Offices (Districts) as contrasted with state-of-the-art methods, which may not have been demonstrated in full-scale applications. The Corps of Engineers conducted research to investigate state-of-the-art dredged material dewatering techniques under the Dredged Material Research Program (DMRP). Based on DMRP research, a number of dewatering methods have been recommended for implementation.

The purpose of this note is to describe which of the dewatering practices recommended by DMRP research have been implemented and to determine whether these practices work as well in full-scale applications as was envisioned based on research studies. Also, innovative dewatering techniques developed or applied by the Districts is documented to encourage further investigation and possible use.

BACKGROUND: Dewatering dredged material is a concern only in confined upland disposal areas because of the potential gain in storage volume accomplished by removing water and the improvement of the soil properties upon dewatering. Because of increasing concern regarding use of land adjacent to or near the water body being dredged, dewatering is becoming more and more important. Land use concerns are typically based on aesthetic, environmental, development, and political concerns.

ADDITIONAL INFORMATION: Contact Ms. Marian E. Poindexter, commercial and FTS: (601) 634-2278, or the manager of the Environmental Effects of Dredging Programs, Dr. Robert M. Engler, (601) 634-3624, for additional information.

Dewatering Methods

Dewatering (also referred to as densification) of dredged material may be divided into two major categories: physical and mechanical methods. Physical methods include application of a surcharge load once a surface crust capable of supporting the load has developed, underdrains to promote drainage of water from the bottom of the dredged material layer, and desiccation of the surface

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due to the natural phenomena of evaporation and transpiration. Mechanical methods include surface mixing (tillage) to break up the surface crust and surface trenching to promote efficient drainage of rainfall which would otherwise pond on the surface and need to be removed by evaporation.

Although other state-of-the-art dewatering methods were investigated (Tiederman and Reischman 1973, Garbe et al. 1974, Environmental Engineering Consultants 1976, Haliburton et al. 1977, Johnson et al. 1977, Chamberlain and Blouin 1977, Brown and Thompson 1977, Bartos 1977, O'Bannon 1977, Palermo 1977, Haliburton 1978, and Hammer 1981), desiccation due to surface evaporation was found to be the most cost-effective means of causing volume reduction in dredged material. It was found that surface trenching could be incorporated with natural evaporation to obtain efficient containment area dewatering (Haliburton 1978). The other methods of dewatering dredged material were found to work with varying degrees of success, and in general to depend on material characteristics.

District Dewatering Survey

This study consisted of a survey of Districts using upland dredged material disposal areas. The survey form asked for information regarding:

- Number and size of upland disposal areas.

- Rate at which these existing disposal areas are being filled.

- Dewatering methods used--past and present.

- How effective these methods have been in full-scale use.

- Primary purpose(s) for dewatering at these disposal areas.

- Types of monitoring used to identify dredged material volume reduction due to dewatering.

- Economic effectiveness of dewatering (does it produce significant volume reduction considering the cost associated with the dewatering method).

The survey of District dewatering methods is summarized in the following paragraphs. The responses illustrate the similarities and differences among Districts with regard to dredged material dewatering practices. Table 1 is a summary of active dewatering methods.

Table 1
Dewatering Practices Used by Survey Respondents

<u>District</u>	<u>Number of Upland Disposal Areas</u>	<u>Dewatering Methods Used (number of sites in use)</u>
Charleston	70	trenching (8) underdrains (3)
Detroit	15	underdrains (1)
Galveston	200	trenching (8)
Norfolk	1	trenching (1)
Philadelphia	76	trenching (10)
Savannah	12	trenching (7)
Wilmington	76	trenching (3) underdrains (1)

Charleston District

The Charleston District operates 70 disposal areas, ten of which are managed intensively for dewatering. The larger disposal areas which are managed for dewatering, along with the size, disposal frequency, and disposal volume (in million cubic yards, or MCY), are tabulated below:

<u>Name</u>	<u>Size acres</u>	<u>Disposal Frequency</u>	<u>Volume Disposed per Dredging, MCY</u>
Clouter Creek	1,600	continuous	3.0*
Daniel Island	700	annual	1.5
Morris Island	550	alternate years	1.5
Yellow House Creek	600	annual	0.5
Drum Island	150	alternate years	1.0
Waccamaw Neck	280	alternate years	1.0
Waccamaw Point	140	alternate years	1.0
Sampit River	230	alternate years	1.0

* Averages about 3.0 MCY per year.

Trenching is used at all of the disposal areas listed above. Underdrains are used at Drum Island, Daniel Island, and Sampit River disposal areas. Figure 1 shows the construction of an underdrain system at one of the Charleston dredged material disposal areas. Perforated pipe wrapped in a geotextile filter fabric is placed in trenches and backfilled with dewatered

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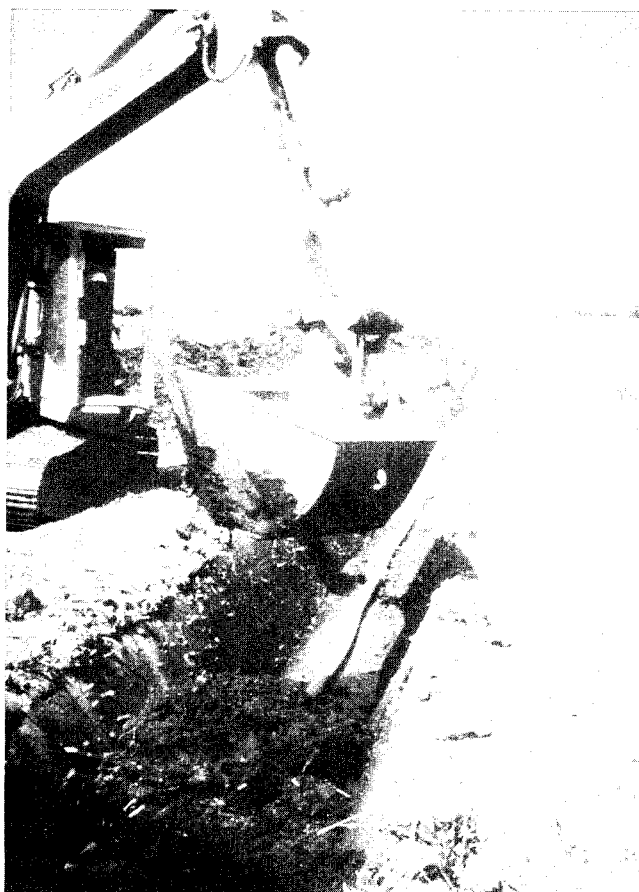


Figure 1. Construction of underdrains at Daniel Island, Charleston District

dredged material. The Charleston District reports that both of these methods effectively accelerate the rate of dewatering by removing free water from the subsurface lifts of dredged material. The primary purposes for dewatering dredged material in the Charleston District are to allow equipment access to the disposal area's interior to obtain dry borrow material required for dike raising and to regain storage volume at the site.

Crust formation resulting from material evaporative drying allows other dewatering activities in the disposal areas. The dried crust provides a base for equipment to operate on while trenching. This promotes further dewatering which provides dewatered dredged material for subsequent stripping and use as construction material for dike raising.

Experience indicates that perimeter trenching can be initiated before the "ideal" crust forms. When a ditch section is not stable and caves in during construction, continued digging at a shallower depth is recommended, followed

later by deepening of the ditch. The initial shallow ditch will help drain the area in preparation for the eventual deeper ditch.

Detroit District

The Detroit District manages 15 disposal areas which are either upland, nearshore (peninsular), or island types. The size of these disposal areas ranges from 8 to 700 acres; most are used on an annual disposal frequency with between 0.01 and 0.5 MCY disposed per year. Adjustable weirs or sand filters are provided at all confined disposal areas, except one which does not have an outlet. Underdrains are used at one disposal area.

These dewatering practices are considered to be effective in providing an acceptable amount of dewatering. Dewatering practices are implemented to provide additional volume for more dredged material disposal and to prevent ponding of water. It is felt that evaporative drying does provide for significant dredged material volume reduction. The Detroit District recommends the use of alternate disposal cells followed by natural dewatering (consolidation and evaporation) in alternate seasons.

Galveston District

The Galveston District manages 200 dredged material disposal areas. The annual amount of dredging work performed is estimated to be between 35 and 40 MCY per year. The Galveston District performs trenching at the following disposal areas:

- Gulf Intracoastal Waterway, Area No. 85.
- Gulf Intracoastal Waterway, Area No. 86.
- Gulf Intracoastal Waterway, Area No. 90.
- Gulf Intracoastal Waterway, Area No. 2.
- Gulf Intracoastal Waterway, Area No. 3.
- Houston Ship Channel, West Jones Area.
- Galveston Harbor and Channel, Pelican Island Area.
- Galveston Harbor and Channel, San Jacinto Area.

The primary purposes of the District's dewatering program are to consolidate the foundations for new dikes and to provide borrow material for dike raising. The trenching is effective since it allows rain to quickly drain off the drying material, thus preventing resaturation of the previously dried material. Perimeter ditches also aid in drying borrow areas within containment areas; this in turn allows material from borrow areas to be used in dike construction.

Evaporative drying is beneficial in providing a material which is easier to handle and is dry enough for use in dike construction. Also, crust formation makes it possible for draglines to operate inside the disposal areas during dike construction by the "side-cast" method. The primary benefit of trenching for the District is increased storage volume.

The Galveston District would like to see the development of more efficient equipment which would trench faster and with less applied ground pressure. They would like to start trenching sooner and to minimize the cost of trenching.

Norfolk District

The Norfolk District manages the 2,500-acre Craney Island Disposal Area for dewatering. This site is subdivided into three containment areas of approximately 800 acres each. Dredged material is disposed into Craney Island on a semicontinuous basis for a total of approximately 5 MCY per year. Disposal is rotated among the three individual containment areas so that each one receives dredged material for one year and is allowed to dry for two years. The three Craney Island compartments are actively dewatered during the two-year drying period by trenching.

Aerial surveys show that additional storage volume has been realized due to dewatering efforts over the last two years. The District is currently monitoring volume reduction during dewatering using aerial surveys along with settlement plate evaluations. A secondary benefit of dewatering efforts is accessibility of the interior of the disposal area.

The Norfolk District is currently evaluating the potential use of under-drains placed in surface trenches in the crust from the previous disposal. Based on experiences with dewatering, the Norfolk District recommends that dewatering practices should be developed and used to the greatest extent possible.

Philadelphia District

The Philadelphia District manages approximately 32 disposal areas which are government owned and approximately 44 disposal areas which were obtained by local sponsors. All of these are upland-type disposal areas. The disposal areas which are managed for dewatering along with size, disposal frequency, and disposal volume are tabulated on the next page:

Name	Size acres	Disposal Frequency	Volume Disposed per Dredging, MCY
Oldmans	201	annual	2.4
Pedricktown North	560	3 out of 6 yr	2.4
Pedricktown South	525	3 out of 6 yr	2.4
Killcohook A,B,C	1,160	2 areas: 3 out of 8 yr 1 area: 2 out of 8 yr	0.5
Willmington Harbor	150	2.5 out of 5 yr	0.9*
Edgmoor	210	2.5 out of 5 yr	0.9*
Courthouse Point	170	alternate years	0.5
Pearce Creek	250	annual	0.3

* Averages about 0.9 MCY per year.

Dewatering is performed by trenching as well as by placement of thin lifts of material over a larger area versus placing of thick layers over a smaller area. Dewatering is effective because it provides volume reduction, provides better material for dike raising, improves trafficability within the disposal area, and prevents ponding of rainwater which resaturates the previously dried material.

Some of the Philadelphia District's disposal areas have been used for storage of large quantities of dredged material and therefore have rather high dikes. When dikes are raised, the new dike must be constructed on top of and inside of the existing dike. The foundation material for the raised dike section is the material located just inside the old dike section. Because perimeter trenches are filled with relatively soft dredged material to a deeper depth than the remainder of the disposal area, perimeter trenching is believed to undermine the foundation for high dikes.

The main benefit of evaporative drying is the increase in trafficability for perimeter dike construction. The Philadelphia District recommends that unless a District has large areas available for dredged material disposal, dewatering practices should be used whenever possible. Also recommended is the use of District-owned ditching equipment which allows dewatering management to be an internal operation instead of being conducted at the discretion and for the benefit of a local sponsor.

The Philadelphia District believes that identifying beneficial uses for large volumes of fine-grained dredged material would provide a breakthrough in improving dredged material disposal operations. For example, if dewatered dredged material could be removed from the disposal area for a beneficial use,

then the useful life of existing disposal areas would be increased, avoiding the need for as many new disposal areas. Also development of disposal areas in ways which allow use by the local population might reduce local opposition.

Savannah District

The Savannah District manages 11 Corps and 3 Navy disposal areas. Two are open water disposal areas and twelve are upland disposal areas. Seven of the upland disposal areas are managed for dewatering. The disposal areas managed for dewatering, along with size, disposal frequency, and disposal volume, are tabulated below:

<u>Name</u>	<u>Size acres</u>	<u>Disposal Frequency</u>	<u>Volume Disposed per Dredging, MCY</u>
Area 12	1,195	annual	3.50
Area 13A	1,481	alternate years	1.60
Area 13B	589	alternate years	1.60
Argyle-Hutchinson	340	annual	0.45
Mainside	160	annual	<1.00
Jones-Oyster Bed	2,637	alternate years	0.50
Area 14	792	18 months	0.35

Trenching is used on a regular basis at Area 12, Area 13A, Area 13B, Jones Oyster Bed, and Area 14 disposal areas. The Argyle-Hutchinson and Mainside disposal areas are trenched at irregular intervals. Figure 2 shows the construction of trenches at a Savannah dredged material disposal area using a low ground pressure, rubber-tired vehicle with a trench digging attachment. The Savannah District reports that trenching is very effective since it shrinks dredged material which increases disposal area capacity and also reduces mosquito-breeding habitat. In the long term the volume reduction due to dewatering reduces the required frequency for dike improvements which reduces costs. The Savannah District reports that two primary purposes for their dewatering program are to provide additional volume for dredged material disposal and mosquito control.

The main benefit of evaporative drying is the formation of the surface crust which is essential for ditching activities. Some reduction in volume is achieved through evaporative drying, but significant volume reduction is achieved through ditching.



Figure 2. Construction of trenches at Savannah

The Savannah District does not recommend purchasing prototype equipment for dewatering activities. Some prototype equipment the Savannah District used broke down, needed frequent repairs, and did not work as well as advertised. The Savannah District would like to use equipment with lower ground pressure than is currently in use. Their problem is the same as other Districts in that trenching is needed for dewatering, but some dewatering must occur before trenching can be accomplished.

Wilmington District

The Wilmington District operates 76 upland disposal areas of which three are actively undergoing dewatering. These include the 800-acre Eagle Island, 250-acre MOTSU DA4, and 125-acre MOTSU DA1 disposal areas. The Eagle Island disposal area receives approximately 1 MCY of dredged material per year with trenching performed to aid in dewatering. The MOTSU DA4 disposal area receives approximately 1.5 MCY per year of dredged material with trenching performed to assist dewatering. The MOTSU DA1 disposal area receives approximately 0.6 MCY of dredged material from dredging performed every three years with both trenching and underdrains used for improved dewatering.

The Wilmington District reports that trenching enhances drying, increasing the available dry material for dikes and the volume capacity of the site. The Wilmington District has experimented with an underdrainage technique using perforated 5-in.-diameter drainage pipe wrapped in filter fabric. The wrapped

pipes are laid on the dried crust from the previous disposal, taking advantage of the natural slope of the dredged material to facilitate drainage. The next layer of dredged material is then placed over the drainage pipes. The under-drainage system has been flowing continuously for nearly three years and is effective in removing water from the material near the bottom of each layer of dredged material.

Additional Studies

Additional studies investigating dredged material dewatering are in progress at WES. A technical report providing more detailed information on this subject is currently in draft form. Dr. Jack Fowler, Geotechnical Laboratory, WES, is preparing a video report illustrating successful dredged material dewatering practices. A recent field study investigated trafficability requirements of equipment working in dredged material disposal areas to gather information about field conditions which are necessary before equipment can successfully work in disposal areas. A report on this field study is also forthcoming.

Summary

Previously conducted DMRP research investigated a number of dewatering techniques for potential use in confined dredged material disposal areas. Evaporative drying combined with surface trenching was determined to be a cost-effective method for use with large volumes of dredged material. Use of underdrainage systems was found to be technically feasible, but more expensive than surface trenching.

A survey of Corps of Engineers District Offices provided information on dewatering practices being used by the various Districts. This survey found that approximately 60 percent of the Districts responding to the survey use surface trenching to enhance evaporative drying of their confined disposal areas. Also, 25 percent use underdrainage systems to promote dewatering in their disposal areas. Underdrainage systems were found to be feasible in some Districts since the surface crust of a previously dried dredged material layer provided an in-place pervious horizontal drainage layer which merely had to be intercepted by trenching and provided with a drainage path to the weir.

Those Districts which have active dewatering programs report that their dewatering efforts are successful in meeting their objectives for dewatering. These objectives include accelerating the removal of water from the dredged material and allowing for the removal of more water from the dredged material than would otherwise be possible. Both of these objectives allow for an increase in storage at a given disposal area. The increased storage capacity prolongs the life of the disposal area and allows for the construction of dikes using dewatered dredged material. The consensus of those Districts with active dewatering programs is that the use of surface trenches and underdrains works well in full-scale practice, just as was envisioned based on DMRP research.

References

- Bartos, Michael J. 1977. "Containment Area Management to Promote Natural Dewatering of Fine-Grained Dredged Material," Technical Report D-77-19, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
- Brown, Kirk W., and Thompson, L. J. 1977. "Feasibility Study of General Crust Management as a Technique for Increasing Capacity of Dredged Material Containment Areas," Technical Report D-77-17, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
- Chamberlain, Edwin J., and Blouin, Scott E. 1977. "Freeze-Thaw Enhancement of the Drainage and Consolidation of Fine-Grained Dredged Material in Confined Disposal Areas," Technical Report D-77-16, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
- Environmental Engineering Consultants, Inc. 1976. "Laboratory Study of Aeration as a Feasible Technique for Dewatering Fine-Grained Dredged Material," Contract Report D-76-10, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
- Garbe, Carl W., Smith, David D., and Amerasinghe, Sri. 1974. "Demonstration of a Methodology for Dredged Material Reclamation and Drainage," Contract Report D-74-5, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
- Haliburton, T. Allan. 1978. "Guidelines for Dewatering/Densifying Confined Dredged Material, Synthesis Report," Technical Report DS-78-11, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
- Haliburton, T. Allan, et al. 1977. "Effects of Mechanical Agitation on Drying Rate of Fine-Grained Dredged Material," Technical Report D-77-10, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
- Hammer, David P. 1981. "Evaluation of Underdrainage Techniques for the Densification of Fine-Grained Dredged Material," Technical Report EL-81-3, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
- Johnson, Stanley, J., et al. 1977. "State-of-the-Art Applicability of Conventional Densification Techniques to Increase Disposal Area Storage Capacity," Technical Report D-77-4, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
- O'Bannon, Charles E. 1977. "Field Study to Determine the Feasibility of Electro-Osmotic Dewatering of Dredged Material," Miscellaneous Paper D-77-2, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
- Palermo, Michael R. 1977. "An Evaluation of Progressive Trenching as a Technique for Dewatering Fine-Grained Dredged Material," Miscellaneous Paper D-77-4, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
- Tiederman, W. G., and Reischman, M. M. 1973. "Feasibility Study of Hydrocyclone Systems for Dredge Operations," Contract Report D-73-1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.